Consumers Caring Health with End Products (Ayurvedic Medicines) Containing *Neopicrorhiza scrophulariiflora* in Nepal

Research Article

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Abstract

Neopicrorhiza scrophulariiflora (Pennell) D. Y. Hong is an endangered herbaceous medicinal plant found in subalpine and alpine zone of eastern Himalayas comprising Sikkim, Nepal, Bhutan and China. Rhizomes of *Neopicrorhiza scrophulariiflora* (hereinafter referred to as *Neopicrorhiza*) have medicinal properties and are highly traded in Nepal, India and China. Information on driving factors for demand of *Neopicrorhiza* from consumer perspective is unknown, knowledge of which is important because it can allow insights into future demand and sustainability of future trade. In this context, a survey was conducted among purchasers and consumers (patients) of end products (Ayurvedic medicines) containing *Neopicrorhiza* (n=513) in five different cities of Nepal from March to July 2017 using structured questionnaire to explore characteristics of consumers and consumption of end products of *Neopicrorhiza.* The utilization of Ayurvedic medicines containing *Neopicrorhiza* for treatment of health disorders of human is prevalent in Nepal. Men and women patients of diverse ages and with different socio-economic profiles were found to consume Ayurvedic medicines containing *Neopicrorhiza* to treat health disorders associated with different organ systems of body. The patients receiving Ayurvedic medicines containing *Neopicrorhiza* were children, adults and elders ranging from 1 to 98 years old (av. 37.6 years). Employed and unemployed, educated and illiterate consumers were found to consume Ayurvedic medicines containing *Neopicrorhiza* to treat their health disorders in Nepal. Patients receiving those medicines were from households having diverse annual cash income levels. The purchase and consumption of Ayurvedic medicine containing *Neopicrorhiza* was most often guided by a doctor's prescription. Most of the respondents believed that the prices of those Ayurvedic medicines were fairer than other types of medicines. Similar studies are recommended in other countries like India and China where the *Neopicrorhiza* is exported from Nepal.

Keywords: *Neopicrorhiza*, purchasers, consumers, characteristics, health disorder, Ayurvedic medicines

Introduction

For most of the world's population, plants, based on many well-established systems of medicine, in either crude or extract form, represent the foundation of primary health care for the foreseeable future (1). Current evidence indicates that a huge number of people rely on medicinal plant products to maintain their health or treat health disorders, and that this number is unlikely to decrease in the foreseeable future (2). Thousands of species of plants are used in traditional and modern medicine throughout the world, and many more species are important to the growing market for plant-based cosmetics, essential oils, food, beverages and other products, representing by far the biggest use of the natural world in terms of number of species (3, 4, 5, 6, 7, 8). Herbal medicines have long been used for the prevention and treatment of a wide range of medical conditions, as well as for general health enhancement (9, 10, 11).

Neopicrorhiza scrophulariiflora (Pennell) D. Y. Hong, Scrophulariaceae family, (hereinafter referred to as *Neopicrorhiza*) is an endangered medicinal herb found in the subalpine as well as alpine zone of the eastern Himalayas comprising Sikkim, Nepal, Bhutan and China (13,14). *Neopicrorhiza*, locally called *Kutki*, is assessed as being vulnerable in Nepal (15). Its dry rhizomes have been used for healing for centuries, which has become a commercial medicinal plant product nowadays. Nepal is estimated to supply 66 ± 12% of *Neopicrorhiza* rhizomes in global supply chain (16). In Nepal, about 1,800 species, including *Neopicrorhiza* are currently in use for production of Ayurvedic, Unani, and Siddha medicines (17) and also for essential oils, cosmetics, aromatic foods and perfumes (18). Some studies have indicated a rising demand for Himalayan plant based medicinal and cosmetic products (19, 20) that will foster demand of raw materials, hence could lead to rise in harvest level of this species. The volume of medicinal plants traded from Darchula District of far-western Nepal in the fiscal year 2014-15 was 401 tons with a harvester value of USD 5.5 million, representing a 2.3 fold increase in

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volume and 17.2 fold increase in value compared to 1997-98 (55). Commercial gathering of selected medicinal plant species to meet increasing national and international market demand can result in over-exploitation (12). Ghimire et al. (21) reported that the size class of rhizomes of *Neopicrorhiza* harvested for trade was significantly smaller than those collected for health care, leading to premature harvesting. The trade may pose sustainability threats that are best understood by combining species-level biophysical, trade, and consumer studies (55). Despite the high levels of trade, information about the consumers and consumption of the end products of *Neopicrorhiza* is lacking in literature, hence leaving an information gap on what drives its demand. Obtaining product-level knowledge of demand drivers is a key research gap, closing it would allow us to more accurately predict trade changes and associated concerns, such as what species are likely to need (more) protection. There is not a single consumer survey study available for any of the species traded from Darchula District of far-western Nepal including *Neopicrorhiza*, and hence the factors determining the demand for any of these species remain unknown (55). Knowledge on consumption of medicinal plant products is essential for prediction of future demand of species and planning for sustainability of harvesting. The aim of this paper is to contribute for an understanding of the consumer characteristics and consumption of end products of commercially important medicinal plants by exploring the prevalence of consumption of the Ayurvedic medicines containing *Neopicrorhiza* in Nepal. Ayurvedic medicines in this study refer to finished herbal medicines that contain as active ingredients, parts of plants, or other plant materials, or combinations, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental disorders.

Materials and Methods

The research was based on inductive social approach (56, 57) that begins with detailed observations of the world using social research methods, which moves towards more abstract generalizations and ideas, rather than applying hypothesis or theory. Three large cities from terai region (Butwal, Bharatpur, Birgunj) and two large cities from mid hill region (Gorkha headquarter and Kathmandu) were randomly selected for consumer study. Data were collected through consumer surveys in five cities of Nepal from March to July 2017. Face to face interviews were conducted using structured questionnaire with purchasers of the *Neopicrorhiza*-containing Ayurvedic medicine/s in Ayurvedic pharmacies on the spot. Prior consent was taken with respondents before the interview. Nineteen enumerators working in the Ayurvedic pharmacies having good knowledge on the ingredients of the medicines were mobilized for surveys. These enumerators were able to identify the Ayurvedic medicine in which *Neopicrorhiza* was present as an ingredient, so they conducted interviews to those who purchased only those medicines. The list of Ayurvedic medicines containing *Neopicrorhiza* used in this research is available in Kafle et.al., (53). One hundred one (101) purchasers of *Neopicrorhiza*-containing Ayurvedic medicines were surveyed in Bharatpur (19.7%), 12 in Birgunj (2.3%), 167 in Butwal (32.6%), 52 in Gorkha Headquarter (10.1%), and 181 in Kathmandu (35.3%). In total, 513 purchasers were surveyed: a) 280 in terai and b) 233 in mid hill.

The main tool for the data collection was a structured questionnaire, finalized after pre testing and was composed of three main sections. Section one of the questionnaire included demographic characteristics of the respondents mainly sex, age, education, household annual cash income and belief on price and side effects of the Ayurvedic medicines. Section two included demographic characteristics of the patients or consumers mainly sex, age, education and occupation. Section three included characteristics related to consumption of *Neopicrorhiza*-containing Ayurvedic medicines mainly name of the medicine, prescription status, combination with allopathic medicine, belief on the price and side effects of the medicine, annual (past year's) expense on the medicine and quantity of the medicine purchased for consumption. The questionnaire is available in Smith-Hall et al. (51).

The research did not require approval of ethics from government of Nepal since it was a pure academic research mainly based on non-invasive and non-destructive methods (i.e. interviews) with full anonymity of the respondents. In this study, the respondents refer to purchasers of the Ayurvedic medicine/s containing *Neopicrorhiza* and the consumers refer to patients who will consume the purchased Ayurvedic medicine/s containing *Neopicrorhiza*, starting consumption within 24 hours from the time of purchase. The words ‘consumer’ and ‘patient’ are used interchangeably in this paper. The words ‘respondent’ and ‘purchaser’ are used interchangeably in this paper.

Data were analyzed using IBM Statistics SPSS 20. Descriptive statistics including frequency, percentage, mean, standard deviation as well as inferential statistics including binomial test and Chi square test were used. As we did not know about the population containing respondents, non-parametric tests were chosen for inferential analysis. One sample Chi square and binomial test were used to examine the statistical differences in different categories of the variables. Association of demographic variables with consumer’s preference for prescribed versus non prescribed *Neopicrorhiza* products was examined using Chi square test. Association of health disorder type and age of the consumers was examined with Chi square test. Nepali Rupees (NRs) was converted into United States Dollar (USD) using the rate specified on 29 February 2018: 1 USD = 103.50 NRs according to Central Bank of Nepal (22).

Results

Characteristics of purchasers of Ayurvedic medicines containing *Neopicrorhiza* (respondents)

Characteristics of the respondents are summarized in table 1. The respondents comprised of 60.4% male and 39.6% female. Out of 513 respondents who participated in this study, the highest age frequency (n=320; 62.4%) was between 26 to 50 years of age, and

the lowest age frequency (n=4; 0.8%) was above 75 years of age. The mean age of the respondent was 36.5±12.9 years. The highest education frequency (n=145; 28.3%) was intermediate and equivalent level and the lowest education frequency (n=25; 4.9%) was postgraduate and above. The respondents had different annual household cash income level. Most of the respondents (n=168; 32.7%) had annual household cash income of USD 966.19 to 1932.37 while the lowest number of respondents (n=48, 9.4%) had that of USD 2898.56 to 3864.73.

Table 1 Characteristics of purchasers of Ayurvedic medicines containing *Neopicrorhiza* (respondents)

Variable	Frequency	Percentage
Sex		
• *Males*	310	60.4
• *Females*	203	39.6
Age (years)		
• *Up to 25*	117	22.8
• *26-50*	320	62.4
• *51-75*	72	14.0
• *Above 75*	4	0.8
Education		
• *Illiterate*	32	6.2
• *Primary*	58	11.3
• *Lower secondary*	29	5.7
• *Secondary*	47	9.2
• *SLC and equivalent*	80	15.6
• *Intermediate and equivalent*	145	28.3
• *Graduate and equivalent*	97	18.9
• *Postgraduate equivalent and above*	25	4.9
Household income (cash) USD/year		
• *0 to 966.18*	88	17.2
• *966.19 to 1932.37*	168	32.7
• *1932.38 to 2898.55*	84	16.4
• *2898.56 to 3864.73*	48	9.4
• *3864.74 to 4830.92*	58	11.3
• *Above 4830.92*	67	13.1

SLC = School Leaving Certificate (to be received after successful completion of 10 years of school level education in school in Nepal)
Exchange rate: 1 USD = 103.50 Nepali Rupees (NRs) as of 28 February 2018 according to Central Bank of Nepal (22)

Consumption of *Neopicrorhiza*-containing Ayurvedic medicines

In total, 513 respondents were interviewed using structured questionnaire who purchased at least Ayurvedic medicine containing *Neopicrorhiza*. 361 respondents (70.4%) purchased only one *Neopicrorhiza*-containing Ayurvedic medicine,75 respondents (14.6%) respondents purchased two *Neopicrorhiza*-containing Ayurvedic medicines, 53 respondents (10.3%) purchased three *Neopicrorhiza*-containing Ayurvedic medicines and 24 respondents (4.7%) purchased four *Neopicrorhiza*-containing Ayurvedic medicines to be consumed by the patients.

A total of 30 Ayurvedic medicines that contain *Neopicrorhiza* as an ingredient were found purchased for consumption by the consumers. Those medicines and the number of consumers consuming particular medicine is presented in table 2. Rohitkyadi Churna, Pilarin, Mahayograj Guggul, Kasarin, Nimbadi Churna, Arogyavardhini Vati, MVLiv, Piles Cure Oil, Hepatop, Asthamarin and Livherb are the top Ayurvedic medicines containing *Neopicrorhiza* in terms of intention for consumption, with Rohitkyadi Churna in first number.

Table 2 Consumption rate of the Ayurvedic medicines containing *Neopicrorhiza* adopted by consumers

***Neopicrorhiza* products**	**Number of responses**	**% respons es**	**% cases**	**Rank**
Rohitkyadi Churna	131	17.7	25.5	1
Pilarin	109	14.7	21.2	2
Mahayograj Guggul	83	11.2	16.2	3
Kasarin	59	8.0	11.5	4
Nimbadi	48	6.5	9.4	5
Arogyavardhin i Vati	38	5.1	7.4	6
MVLiv	30	4.0	5.8	7
Piles Cure Oil	29	3.9	5.7	8
Hepatop	25	3.4	4.9	9
Asthamarin	23	3.1	4.5	10
Livherb	23	3.1	4.5	11
Mana	20	2.7	3.9	12
Kumaryasava	17	2.3	3.3	13
Glowderm	14	1.9	2.7	14
Vata Raktahar Churna	14	1.9	2.7	15
Livosave	13	1.8	2.5	16
Sarivadyasava	12	1.6	2.3	17
Jivan Shakti Prash	10	1.3	1.9	18
Pittaghna	9	1.2	1.8	19
Livotop	7	0.9	1.4	20

Neopicrorhiza products	Number of responses	% responses	% cases	Rank
Tonoliv	6	0.8	1.2	21
Lacchadi Oil	5	0.7	1.0	22
Jameda Churna	4	0.5	0.8	23
Maha Sudarshan Churna	4	0.5	0.8	24
Livorin	3	0.4	0.6	25
Hepadex	2	0.3	0.4	26
Hepagard DS	1	0.1	0.2	27
Livergen	1	0.1	0.2	28
Megaferol	1	0.1	0.2	29
Yakrit Rasayan Churna	1	0.1	0.2	30
Grand Total	742	100	144.6	

The consumers were categorized into two groups according to their preference to the consumption of prescribed or over the counter (OTC) products/ medicines: consumers who prefer prescribed *Neopicrorhiza*-containing Ayurvedic medicines were considered as "guided consumers", consumers who prefer over the counter (OTC) *Neopicrorhiza*-containing Ayurvedic medicines were considered as "free consumers". 382 (74.5%) of the consumers had preference to prescribed *Neopicrorhiza* products, i.e. they were guided consumers. Consumer in this study refers to patient who will consume the purchased Ayurvedic medicine/s containing *Neopicrorhiza*, starting consumption within 24 hours from the time of purchase.

Characteristics of consumers (patients)

Out of the 513 patients, 286 (55.8%) were male. The mean age of patients was 37.6±16.6 years. The patients ranged from 1 to 98 years of age. 267 (52.0%) patients were between 26 to 50 years of age, while 10 (2%) were above 75 years of age. The highest education frequency (n=118; 23.0%) was intermediate level and the lowest education frequency (n=21; 4.1%) was postgraduate and above. The household of the patients had different annual cash income level. Most of the patients (n=168; 32.7%) had annual household cash income of USD 966.19 to 1932.37 while the lowest number of patients (n=48, 9.4%) had that of USD 2898.56 to 3864.73 (Table 3).

Out of the total patients, 382 (74.0%) were about to consume *Neopicrorhiza*-containing Ayurvedic medicines prescribed by an Ayurvedic doctors or health workers. Only 30 (6%) patients were about to *Neopicrorhiza*-containing Ayurvedic medicines in combination with allopathic medicine. All groups of patients including businessmen, farmers, job holders, students, housewives and unemployed persons preferred *Neopicrorhiza*-containing Ayurvedic medicines for their healthcare. Businessmen represented the highest consumers (n=126; 24.5%) while unemployed persons represented the lowest occupation frequency (n=9; 1.7%) (Table 3).

52 respondents believed that the price of Ayurvedic medicines containing *Neopicrorhiza* was low (6.8%), 267 respondents believed that it was high (34.9%), and 447 believed that it was fair (58.4%).

Table 3 Characteristics of patients (consumers) of *Neopicrorhiza*-containing Ayurvedic medicines

Variable	Frequency (%)	Chi Square/ Binomial (Goodness of fit)	p-value
Sex			
Males	286 (55.8)	286	0.010*
Females	227(44.2)		
Age (years)			
Upto 25	136 (26.5)	-	-
26-50	267 (52.0)		
51-75	100 (19.5)		
Above 75	10 (2.0)		
Education			
Illiterate	50 (9.7)	115.195	0.000*
Primary	87 (16.9)		
Lower secondary	30 (5.9)		
Secondary	48 (9.4)		
SLC and equivalent	81 (15.8)		
Intermediate and equivalent	118 (23.0)		
Graduate and equivalent	78 (15.2)		
Postgraduate equivalent and above	21 (4.1)		
Household income (cash) NRs/ year			
0 to 966.18	88 (17.2)	106.287	0.000*
966.19 to 1932.37	168 (32.7)		
1932.38 to 2898.55	84 (16.4)		
2898.56 to 3864.73	48 (9.4)		
3864.74 to 4830.92	58 (11.3)		
Above 4830.92	67 (13.1)		
Was the medicine prescribed by a doctor?			
Yes	382 (74.0)	382.00	0.000*
No	131 (26.0)		
Belief regarding price of the *Neopicrorhiza* product			
Cheap	39(7.6)	188.22	0.000*
Fair	293(57.11)		
Expensive	181(35.28)		

Variable	Frequency (%)	Chi Square/ Binomial (Goodness of fit)	p-value
Is this Ayurvedic medicine used in combination with allopathic medicine to treat the health disorder?			
Yes	30 (6.0)	483.00	0.000*
No	483 (94.0)		
Occupation			
Business	126 (24.5)	106.333	0.000*
Farmer	82 (15.9)		
Housewife	72 (14.04)		
Job holder (salaried)	112 (21.8)		
Student	112 (21.8)		
Unemployed	9 (1.7)		

SLC = School Leaving Certificate (to be received after successful completion of 10 years of school level education in school in Nepal)

Exchange rate: 1 USD = 103.50 Nepali Rupees (NRs) as of 28 February 2018 according to Central Bank of Nepal (22)

Health disorders of patients for which *Neopicrorhiza*-containing Ayurvedic medicine was purchased

The Ayurvedic medicines containing *Neopicrorhiza* were used to treat disorders related to Circulatory system, Digestive system, Hepatobiliary system, Immune system, Integumentary system, Muscular system, Nervous system, Reproductive system, Respiratory system, Skeleton system and Urinary system (Table 4). Highest number of patients (174, 33.29%) had digestive system disorders to treat using Ayurvedic medicines, followed by disorders associated with hepatobiliary system, respiratory system, integumentary system, skeleton system, circulatory system, muscular system, immune system, nervous system, urinary system and reproductive system in chronological order.

Table 4 Health disorder types for which *Neopicrorhiza*-containing Ayurvedic medicine was used

Disorder type	Frequency	Percentage
Circulatory system	**32**	6.24
Anemia	*4*	
Blood impurity	*5*	
Broken blood vessel	*1*	
Diabetes	*5*	
Heartburn	*2*	
High blood pressure	*8*	
Hyperuricemia (High Uric Acid)	*7*	
Digestive system	**174**	33.92
Abdominal pain	*11*	
Abdominal swelling	*2*	
Anorexia (loss of appetite)	*16*	
Anorexia and constipation	*1*	
Anorexia and gastritis	*1*	
Constipation	*9*	
Dyspepsia (indigestion)	*18*	
Dyspepsia and abdominal pain	*1*	
Dyspepsia and anorexia	*1*	
Dysphonia (hoarse voice)	*3*	
Fistula	*1*	
Gastritis	*28*	
Hematochezia (blood from stool)	*3*	
Hemorrhoid (piles)	*78*	
Mouth sores	*1*	
Hepatobiliary system	**85**	16.57
Gallstones (Cholelithiasis)	1	
Hepatitis	1	
Jaundice	36	
Liver disorder	43	
Fatty liver	4	
Immune system	**17**	3.31
Asthenia (weakness)	*15*	
Health maintenance	*1*	
Underweight	*1*	
Integumentary system	**52**	10.14
Acne vulgaris (pimple)	*4*	
Age spots	*2*	
Pruritus (itchy skin)	*13*	
Psoriasis (reddish, scaly rash on skin)	*1*	
Skin allergy	*31*	
Tinea/Ringworm infection/ Eczema	*1*	
Muscular system	**26**	5.07
Burning legs	*1*	
Edema (muscle swelling)	*3*	
Fever	*4*	
Myalgia (muscle pain)	*12*	
Myalgia and Edema	*1*	
numbness in body	*1*	
numbness in body and My-algia	*1*	
Numbness in hands and legs	*2*	
Numbness in knee	*1*	
Nervous system	**9**	1.75
Eating disorder	*1*	
Fatigue	*7*	
Obesity	*1*	
Reproductive system	**5**	0.97
Leucorrhoea (whitish vagi-nal discharge)	*2*	
Metrorrhagia (irregular menstruation)	*2*	
Uterine problem	*1*	
Respiratory system	**67**	13.06
Asthma	*14*	
Chronic bronchitis	*2*	
Chronic cough	*5*	
Cough	*23*	
Cough and common cold	*9*	
Cough and fever	*7*	
Itchy throat	*1*	
Pneumonia	*2*	
Sinusitis	*4*	

Disorder type	Frequency	Percentage
Skeleton system *Rheumatoid Arthritis*	**40**	7.80
Urinary system *Dysuria (painful urination)* *Nephrolithiasis (kidney stones)*	**6** *4* *2*	1.17

The names of disorders were adopted from (23).

Association of demographic variables with patient's preference for prescribed versus non prescribed *Neopicrorhiza*-containing Ayurvedic medicines

Association was found between patient types in terms of preference to consumption of prescribed or non -prescribed medicines and location (cities) (p=0.001), consumption of particular Ayurvedic medicine (p=0.000), occupation of the patient (p=0.023) (Table 5). No association was found between patient types in terms of consumption of prescribed or non-prescribed medicines and annual household cash income, quantity of Ayurvedic medicine purchased for consumption, amount of total expense in Ayurvedic medicine in past 12 months, consumption of the Ayurvedic medicine with other types of medicine, belief of the patient on the price of the Ayurvedic medicine, sex of the patient, age of the patient and education level of the patient.

Table 5 Association of demographic variables with patient's preference for prescribed versus non prescribed *Neopicrorhiza*-containing Ayurvedic medicines

Variables	Chi square	ρ-value
Age	63.077	0.855
Sex	0.039	0.844
Education level	13.330	0.064
Occupation	12.9888	0.023*
Annual household cash income	8.542	0.129
Combination of Ayurvedic medicine with allopathic medicine	0.021	0.884
Belief of the patient on the price of the Ayurvedic medicine	2.711	0.258
Expense on the product during last 12 months	98.514	0.078
* p < 0.05 is considered as statistically significant.	-	

Discussion

This research has provided important insights into the consumption of end products containing *Neopicrorhiza* in Nepal, based on research conducted in five large cities of Nepal. Research on consumer characteristics and consumption of end products of *Neopicrorhiza* is lacking in the scientific literature. In this context, it is believed that this study reveals the characteristics of Nepalese consumers consuming end products containing *Neopicrorhiza* and may serve as an entry point for future studies concerning the consumption of medicinal plant products. The study approach might be useful for replicating similar studies in future.

Children are encouraged to use herbs for their nutritional values to facilitate normal or healthy growth and development; young persons for their euphoric effects, supply essential ingredients to help them cope with daily stress and to prevent or slow the onset of aging; older persons for their anti-aging or rejuvenating effects and women for slimming and beauty enhancing effects (54). Our study showed that children, adults and elders ranging from 1 to 98 years old (av. 37.6 years) consumed Ayurvedic medicines containing *Neopicrorhiza* in Nepal. The number of consumers was found increasing up to 40 years of age but after that decreasing. However, analyzing consumers with 10 years of age interval, the number of respondents of two age categories: 21-30 years and 31-40 years were found with more consumers: 119 and 133 respectively than other age groups. Our findings are consistent with some previous research findings. Du et al. (24) found that use of herbal medicine declines along with increasing age in Germany. Arcury et al. (25) and Ness et al. (26) found that older American individuals did not favor the use of herbal medicine. Thorsen and Pouliot (28) found age as significant determinant of use of traditional medicine in mid hill region of Nepal. The traditional medicine was primarily relied on by middle-aged individuals from relatively uneducated households who were living in villages with limited allopathic medicine service provision (29). It is argued that herbal remedies are likely to be used by the relatively young users (30). The respondent age correlated inversely with the use of herbal supplements among older Americans (26). Arcury et al. (25) found that herbal remedy use declined with age. But in the case of patients with diabetes, previous studies showed contrasting results. Egede et al. (27) found that older age is associated with higher likelihood of using Complementary and Alternative Medicine among people living with diabetes. Older participants were likely to use complementary and alternative medicine in people with type 2 diabetes in Taiwan (31). It might be due to need for long term adherence of older persons to specific medicines for treating specific disease.

We found that both educated and illiterate people consumed Ayurvedic medicines containing *Neopicrorhiza* in Nepal. The majority of the consumers were educated; only 9.7% consumers were illiterate. However, the education levels of the consumers were significantly different (p-value=0.000). Our findings on consumption of Ayurvedic medicines by both literate and illiterate persons, and higher number of literate consumers were consistent with findings of a number of previous researches. Educational level was key determinant of herbal medicinal product use in Germany (24). Egede et al. (27) and Bell et al. (32) found that having a higher educational background is associated with a higher likelihood of using Complementary and Alternative Medicine among people living with diabetes. Education was identified as significant determinant of use of traditional medicine in mid hill region of Nepal (28). Nur (30) argued that herbal remedies are likely to be used by those with

higher education. Ness et al. (26) found that advanced education correlated with fewer chiropractic visits and more dietary and herbal supplement and personal practices use. Education was one of the significant predictor of herb use among older American adults (25). Education did not demonstrate any relationship to complementary and alternative medicine use in people with type 2 diabetes in Taiwan (31). Education often promotes beliefs and ideas that clash with local traditions in developing countries and are associated with a reduction in the use of indigenous herbal/animal medicine (33).

It is found that people from households having diverse annual cash income consumed Ayurvedic medicines containing *Neopicrorhiza* in Nepal. The income levels of the consumers were significantly different (p-value=0.000). About half of the consumers had annual household cash income level USD 966.19 to 2898.55, while only 17.2% consumers had this income level below USD 966.19. Nepal's average monthly household income is USD 277.83 from 2006 to 2015 (34). We found that around two third of the consumers had annual household cash income level below Nepal's average monthly household income. The average annual expenditure on *Neopicrorhiza*-containing Ayurvedic medicine per consumer is only USD 14.8. In Ghana, traditional medicine use was predicted by having low-income levels (35). Sato (36) found that rising income is associated with decreased use of traditional care. Khan et al. (37) and UN Millennium Project (38) reported that the rich are more likely to utilize modern health care, owing to their greater means to access. High income was an important determinant of use of traditional medicine, challenging the common assumption that poor and marginalized people are most reliant on traditional medicine due to its availability (28). In Taiwan, income did not demonstrate any relationship to complementary and alternative medicine use in people with type 2 diabetes (31). In our study, preference to prescribed or non-prescribed *Neopicrorhiza*-containing Ayurvedic medicine was not found significantly associated with annual household cash income level of the consumer (p=0.778).

Our results showed that both employed and unemployed people consumed Ayurvedic medicines containing *Neopicrorhiza* in Nepal. The occupation of the consumers is diverse: business, farmer, housewife, salaried job and student. The share of unemployed consumers was low (1.7%). Nature of occupation (being a trader) was found predictive of traditional medicine use in Ghana (35). In Taiwan, employment status did not demonstrate any relationship to complementary and alternative medicine use in people with type 2 diabetes (31). In our study, preference to prescribed or non-prescribed *Neopicrorhiza*-containing Ayurvedic medicine was found significantly associated with occupation of the consumer (p=0.023), with highest number of consumers as being businessmen (126; 91 taking prescribed medicines and 35 taking non prescribed ones) and lowest as being unemployed (9).

Ayurvedic medicinal plant products are most convenient and have greater acceptance amongst the users due to their easy availability, easy biodegradability, easy to handling, economic cost, mankind and environment friendly nature both and minimum side effect (52). In this study, most respondents believed that the prices of Ayurvedic medicines containing *Neopicrorhiza* are fairer than other types of medicines. One of the factors that hindered herbal medicine use among Ghanaian adults included high cost of herbal products at credible herbal clinics (41).

We found that the Ayurvedic medicines containing *Neopicrorhiza* were used by patients having a number of health disorders associated with Circulatory system, Digestive system, Hepatobiliary system, Immune system, Integumentary system, Muscular system, Nervous system, Reproductive system, Respiratory system, Skeleton system and Urinary system in Nepal. However, there is variation in the number of patients with specific disorders receiving these medicines. We found highest share of patients having abdomen related disorders (259, 50.49%) receiving *Neopicrorhiza*-containing medicines and the lowest share of patients having reproductive system disorders (5, 0.97%) receiving these medicines. It should be noted that the patients might receive other Ayurvedic medicines together with *Neopicrorhiza*-containing Ayurvedic medicines for the treatment of their heath disorders, so we could not generalize about priority of disease types which *Neopicrorhiza*-containing Ayurvedic medicine is effective for. But our study confirmed the diseases to which *Neopicrorhiza*-containing Ayurvedic medicines were used for healing. Previous studies had explored the use of the raw (unprocessed) *Neopicrorhiza* rhizomes to treat various ailments such as liver disorders, fever, asthma, jaundice and have pharmaceutical value for hepatoprotective, immunomodulator and antiasthamatic activities (42, 43, 44) in Indian, Bhutanese, Tibetan and Chinese traditional medicines. Medicinal values of *Neopicrorhiza* are due to the presence of irridoid glycosides such as picroside I and II, and kutkoside (45, 46, 47, 48, 49). An in vitro study suggested antihepatitis B-like activity of *Neopicrorhiza* through reduction in the levels of surface antigens (50).

Conclusion

This research presents a first exploration of consumption of the Ayurvedic medicines containing *Neopicrorhiza* and consumer characteristics in Nepal. The consumption of Ayurvedic medicines containing *Neopicrorhiza* is prevalent in Nepal. These medicines are consumed by children, adults and elders of households having diverse annual household cash income levels. Both illiterate and educated persons prefer these medicines. Majority of the patients prefer to consume medicines after receiving prescription from Ayurvedic doctors and professionals. Major proportions of the patients believe that the price of the *Neopicrorhiza*-containing medicines is fairer than other types of medicines. Majority of the patients did not combine *Neopicrorhiza*-containing Ayurvedic medicines with allopathic medicines. *Neopicrorhiza*-containing Ayurvedic medicines are commonly used to treat health disorders related to Circulatory system,

Digestive system, Hepatobiliary system, Immune system, Integumentary system, Muscular system, Nervous system, Reproductive system, Respiratory system, Skeleton system and Urinary system. The first three health disorders for which more patients receive Ayurvedic medicines containing *Neopicrorhiza* for treatment were digestive system disorders, hepatobiliary system disorders, and respiratory system disorders. Looking at the multiple uses of Ayurvedic medicines containing Kutki and consumers of diverse socio-economic background, it is speculated that the domestic demand of these medicines, therefore of dry rhizomes of *Neopicrorhiza* for manufacturing of those medicines, could rise in future. Similar consumption studies are recommended in India and China where the *Neopicrorhiza* from Nepal is exported, so that driving factors of demand for this species at regional level is identified. The consumption of the end products of Neopicrorhiza was driven by the preference of consumers towards Ayurvedic methods for treatment of health disorders. So further research is recommended to explore why the consumers choose to use Ayurvedic medicines for their healthcare.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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References

1. Cordell GA. Sustainable medicines and global health care. Planta Medica. 2011; 77(11), pp. 1129–1138. doi: 10.1055/s-0030-1270731.
2. Smith-Hall C, Larsen HO, Pouliot M. People, plants and health: A conceptual framework for assessing changes in medicinal plant consumption. Journal of Ethnobiology and Ethnomedicine. 2012; 8. doi: 10.1186/1746-4269-8-43.
3. Schippmann U, Leaman DJ, Cunningham AB. 2002. Impact of Cultivation and Gathering of Medicinal Plants on Biodiversity: Global Trends and Issues. 2002; In book: Biodiversity and the ecosystem approach in agriculture, forestry and fisheries. FAO.
4. Zedan H. Foreword: Global Strategy for Plant Conservation. Grana. 2002; 34(6), pp. 363–366. Available at: http://www.biodiv.org/programmes/cross-cutting/plant/default.asp.
5. WHO. World Health Report: Shaping our future. Geneva, World Health Organization. 2003.
6. Schippmann U, Leaman D, Cunningham AB. A Comparison of Cultivation and Wild Collection of Medicinal and Aromatic Plants Under Sustainability Aspects. Medicinal and Aromatic Plants. 2006; pp. 75–95. doi: 10.1104/pp.900074.
7. Leaman D. Conservation and sustainable use of Wild-sourced Botanicals. Planta Medica. 2008; 74 (03), doi:10.1055/s-2008-1075152
8. Sharrock S, Oldfield S, Wilson O. Plant Conservation Report 2014: A review of progress in implementation of the Global Strategy for Plant Conservation 2011-2020. Secretariat of the Convention on Biological Diversity, Montréal, Canada and Botanic Gardens Conservation International, Richmond, UK. Technical Series No. 81, 56 pages. 2014.
9. Wu CH, Wang CC, Tsai MT, Huang WT, Kennedy J. Trend and pattern of herb and supplement use in the United States: results from the 2002, 2007, and 2012 national health interview surveys. Evid. Based Complement. Altern. Med. 2014; 872320.
10. Zhang AL, Story DF, Lin V, Vitetta L, Xue CC. A population survey on the use of 24 common medicinal herbs in Australia. Pharmacoepidemiol. Drug Saf. 2008; 17 (10), 1006–1013
11. Leach MJ, Lauche R, Zhang AL, Cramer H, Adams J, Langhorst J, Dobos G. Characteristics of herbal medicine users among internal medicine patients: A cross-sectional analysis. Journal of Herbal Medicine. 2017; 10, 59-63. doi:10.1016/j.hermed.2017.06.005.
12. Cunningham AB. African medicinal plants – setting priorities at the interface between conservation and primary health care. UNESCO, Paris: People and Plants Working Paper 1, pp. 50.1993.
13. Hara H, Chater AO, Williams LHJ. Vol. III', in An Enumeration of the Flowering Plants of Nepal. 1982; p. 166.
14. Bantawa P, Ghosh SK, Maitra S, Ghosh PD, Mondal TK. Status and conservation threats of *Picrorhiza scrophulariiflora* Pennell. (Scrophulariaceae): An endangered high valued medicinal plant of Indo-China Himalayan region. Bioremediation, Biodiversity, Bioavailability. 2009a; 3, 15-22
15. Tandon V, Bhattarai NK, Karki M. (Eds.). Conservation assessment and management plan workshop report: selected medicinal plants species of Nepal. Medicinal and Aromatic Plants Program in Asia (MAPPA), International Development Research Centre (IDRC) and Ministry of Forest and Soil Conservation, Kathmandu. 2001.
16. Olsen CS. Trade and conservation of Himalayan

medicinal plants: *Nardostachys grandiflora* DC. and *Neopicrorhiza scrophulariiflora* (Pennell) Hong. Biological Conservation. 2005; 125(4), pp. 505–514. doi: 10.1016/j.biocon.2005.04.013.
17. Baral SR, Khurmi PP. A compendium of medicinal plants in Nepal. Mrs. Rachana Sharma, Kathmandu, Nepal. 2006.
18. GoN/MoC. Nepal Trade Integration Strategy 2016: Executive Summary and Action Matrix. Ministry of Commerce, Government of Nepal, Kathmandu, Nepal. 2016.
19. Holley J, Cherla K. The medicinal plants sector in India. The International Development Research Center, South Asia Regional Office, Medicinal and Aromatic Plants Programme in Asia, Delhi. 1998.
20. Olsen CS. The trade in medicinal and aromatic plants from Central Nepal to Northern India. Economic Botany. 1998; 52(3), pp. 279–292. doi: 10.1007/BF02862147.
21. Ghimire SK, McKey D, Aumeeruddy-Thomas Y. Conservation of Himalayan medicinal plants: Harvesting patterns and ecology of two threatened species, *Nardostachys grandiflora* DC. and *Neopicrorhiza scrophulariiflora* (Pennell) Hong. Biological Conservation. 2005; 124(4), 463-475.
22. Central Bank of Nepal/Nepal Rastra Bank. Foreign Exchange Rates. [Online] Available at: https://nrb.org.np/fxmexchangerate.php?YY=2018&MM=02&DD=28&B1=Go/ (Accessed 28 February 2018).
23. WHO. International Statistical Classification of Diseases and Related Health Problems 10th Revision. World Health Organization, Switzerland. 2013.
24. Du Y, Wolf IK, Zhuang W, Bodemann S, Knöss W, Knopf H. Use of herbal medicinal products among children and adolescents in Germany. BMC Complementary and Alternative Medicine. 2014; 14 (1), p. 218. doi: 10.1186/1472-6882-14-218.
25. Arcury TA, Grzywacz JG, Bell RA, Neiberg RH, Lang W, Quandt SA. Herbal remedy use as health self-management among older adults. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2007; 62(2), S142–S149.
26. Ness J, Cirillo DJ, Weir DR, Nisly NL, Wallace RB. Use of complementary medicine in older Americans: Results from the health and retirement study. Gerontologist. 2005; 45(4), pp. 516–524. doi: 10.1093/geront/45.4.516.
27. Egede L, Ye X, Zheng D, Silverstein M. The prevalence and pattern of complementary and alternative medicine use in individuals with diabetes. Diabetes Care. 2002; 25(2), pp. 324–329. doi: 10.2337/diacare.25.2.324.
28. Thorsen RS, Pouliot M. Traditional medicine for the rich and knowledgeable: Challenging assumptions about treatment-seeking behavior in rural and peri-urban Nepal. Health Policy and Planning. 2016; 31(3), pp. 314–324. doi: 10.1093/heapol/czv060.
29. Pouliot M. Relying on nature's pharmacy in rural Burkina Faso: Empirical evidence of the determinants of traditional medicine consumption. Social Science and Medicine. 2011. 73(10), pp. 1498–1507. doi: 10.1016/j.socscimed.2011.08.037.
30. Nur N. Knowledge and behaviours related to herbal remedies: a cross-sectional epidemiological study in adults in middle Anatolia, Turkey: use of herbal remedies. Health Soc Care Community. 2010;18:389–395. doi: 10.1111/j.1365-2524.2010.00911.x.
31. Chang HYA, Wallis M, Tiralongo E. Predictors of complementary and alternative medicine use by people with type 2 diabetes. Journal of Advanced Nursing. 2011; 68(6), pp. 1256–1266. doi: 10.1111/j.1365-2648.2011.05827.x.
32. Bell RA., Suerken CK, Grzywacz JG, Lang W, Quandt SA, Arcury TA. Complementary and alternative medicine use among adults with diabetes in the United States. Alternative Therapies in Health and Medicine. 2006; 12(5), 16–22.
33. Giovannini P, Reyes-Garcia V, Waldstein A, Heinrich M. Do pharmaceuticals displace local knowledge and use of medicinal plants? Estimates from a cross-sectional study in a rural indigenous community, Mexico. Social Science and Medicine. 2011; 72(6), pp. 928–936. doi: 10.1016/j.socscimed.2011.01.007.
34. CEIC. Nepal average monthly household income: Whole kingdom [Online]. Available at: https://www.ceicdata.com/en/nepal/household-budget-survey-average-monthly-household-income/average-monthly-household-income-whole-kingdom/ (Accessed 28 February 2018).
35. Gyasi RM, Mensah CM, Siaw LP. Predictors of Traditional Medicines Utilization in the Ghanaian Health Care Practice: Interrogating the Ashanti Situation. Journal of Community Health. 2015; 40 (2), pp. 314–325. doi: 10.1007/s10900-014-9937-4.
36. Sato A. Does socio-economic status explain use of modern and traditional health care services? Social Science & Medicine. 2012; 75(8), pp. 1450–1459. doi: 10.1016/j.socscimed.2012.05.032.
37. Khan MM, Hotchkiss DR, Berruti AA, Hutchinson PL. Geographic aspects of poverty and health in Tanzania: Does living in a poor area matter? Health Policy and Planning. 2006; 21(2), pp. 110–122. doi: 10.1093/heapol/czj008.
38. UN Millennium Project. Prescription for Healthy Development: Increasing Access to Medicines. Earthcscan. 2005; Available at: http://www.unmillenniumproject.org/documents/TF5-medicines-Complete.pdf.
39. Marinac JS, Buchinger CL, Godfrey LA, Wooten JM, Sun C, Willsie SK. Herbal Products and Dietary Supplements: A Survey of Use, Attitudes, and Knowledge Among Older Adults." The Journal of the American Osteopathic Association. 2007; 107(1): 13-23.
40. Altizer K, Quandt SA, Grzywacz JG, Bell RA, Sandberg J, Arcury TA. Traditional and Commercial Herb Use in Health Self-Management among Rural Multiethnic Older Adults. Journal of applied gerontology : the official journal of the Southern Gerontological Society. 2013; 32(4):387-

ISSN: 0976-5921
International Journal of Ayurvedic Medicine, 2018, 9(2), 123-132

407. doi:10.1177/0733464811424152.
41. Aziato L, Antwi HO. Facilitators and barriers of herbal medicine use in Accra, Ghana: an inductive exploratory study. BMC Complementary and Alternative Medicine. 2016;16:142. doi:10.1186/s12906-016-1124-y.
42. Ghisalberti EL. Biological and pharmacological activity of naturally occurring iridoids and secoiridoids. Phytomedicine. 1998; pp. 147–163. doi: 10.1016/S0944-7113(98)80012-3.
43. Smit H F, Kroes BH, van den Berg AJJ, van der Wal D, van den Worm E, Beukelman CJ, … Labadie RP. Immunomodulatory and anti-inflammatory activity of *Picrorhiza scrophulariiflora*. Journal of Ethnopharmacology. 2000; 73(1–2), pp. 101–109. doi: 10.1016/S0378-8741(00)00268-3.
44. Bantawa P, Roy OS, Ghosh P, Mondal TK. Effect of bavistin and adenine sulphate on in vitro shoot multiplication of *Picrorhiza scrophulariiflora* Pennell.: An endangered medicinal plant of Indo-China himalayan regions. Plant Tissue Culture and Biotechnology. 2009b; 19(2), pp. 237–245.
45. Rastogi RP, Sharma VN, Siddiqui S. Chemical examination of *Picrorhiza kurroa* Benth Part 1. Journal of Scientific & Industrial Research. 1949; 8B:173-178.
46. Kitagawa I, Hino K, Nishimura T, Mukai E, Yosioka I, Inouye H, Yoshida T. Picroside I: A bitter principle of *Picrorhiza kurroa*. Tetrahedron Letters. 1969; 10(43), pp. 3837–3840. doi: 10.1016/S0040-4039(01)88526-9.
47. Weinges K, Kloss P, Henkels WD. Picrosid-II, ein neues 6-vanilloyl-catalpol aus *Picrorhiza kurroa* Royle und Benth. Liebigs. Ann. Chem. 1972; 759, pp. 173-182.
48. Jia Q, Hong MF, Minter D. Pikuroside: A novel iridoid from *Picrorhiza kurroa'*, Journal of Natural Products. 1999; 62(6), pp. 901–903. doi: 10.1021/np980493+.
49. Bantawa P, Saha-Roy O, Ghosh SK, Mondal TK. In vitro regeneration of an endangered medicinal plant *Picrorhiza scrophulariiflora*. Biologia Plantarum. 2011; 55(1), pp. 169–172. doi: 10.1007/s10535-011-0024-8.
50. Mehrotra R, Rawat S, Kulshreshtha DK, Patnaik GK, Dhawan BN. In vitro studies on the effect of certain natural products against hepatitis B virus. The Indian journal of medical research. 1990; 92, pp. 133–138.
51. Smith-Hall C, Pouliot M, Pyakurel D, et al. Data collection instruments and procedures for investigating national-level trade in medicinal and aromatic plants: the case of Nepal. 2018; IFRO Documentation 2018/2, Vol. 2, 204pp. Department of Food and Resource Economics, University of Copenhagen.
52. Meena A K, Bansal P, Kumar S . Plants herbal wealth as a potential source of ayurvedic drugs. Asian J Tradit Med 2009; 4 :152–70
53. Kafle, G., Siwakoti, M., & Shrestha, A. K. (2018). Demand, End-Uses, and Conservation of Alpine Medicinal Plant Neopicrorhiza scrophulariiflora (Pennell) DY Hong in Central Himalaya. *Evidence-Based Complementary and Alternative Medicine, 2018*
54. Parle M, Bansal N. Herbal medicines: are they safe? Nat. Prod. Rad. 2006; 5, 6–14.
55. Pyakurel D, Bhattarai Sharma I, Smith-Hall C. Patterns of change: the dynamics of medicinal plant trade in far-western Nepal. Journal of Ethnopharmacology. 2018; https://doi.org/10.1016/j.jep.2018.06.004
56. Babbie, Earl R. The basics of social research. Cengage Learning, 2013.
57. Bryman, Alan. Social research methods. Oxford University Press, 2016.

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